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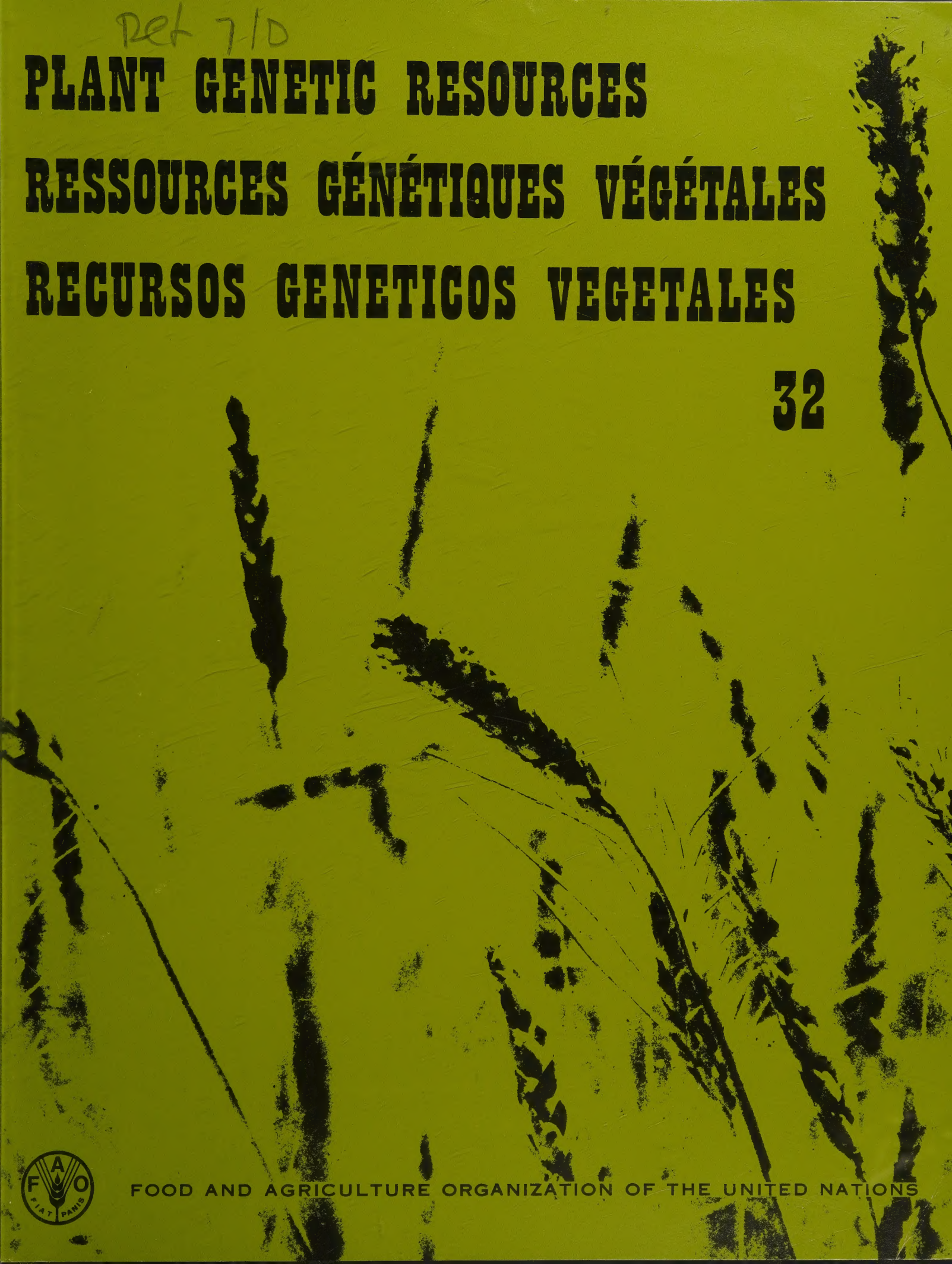

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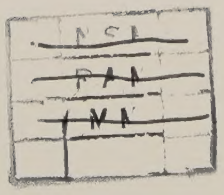
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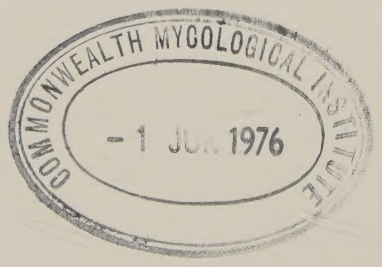
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PLANT GENETIC RESOURCES

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ROME, 1976

The Plant Genetic Resources Newsletter is published under the auspices of the Crop Ecology and Genetic Resources Unit of FAO. Its field of interest embraces genetic conservation in its widest sense, including plant exploration and collection, seed storage, exchange and physiology, all aspects of utilisation and evaluation of the genetic resources of cultivated plants, both in collections and in the field. Any reports on practical activities, and any discussions on theoretical aspects of the general problem of genetic conservation which are received, will be considered for publication. Contributions may be submitted directly to Rome or to any one of the following persons:

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THE FIRST SIX YEARS

Postgraduate training at Birmingham

by
J.G. Hawkes and J.T. Williams
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INTRODUCTION

The international postgraduate training course in Conservation and Utilisation of Plant Genetic Resources in the Department of Botany, University of Birmingham, U.K. was inaugurated in the autumn of 1969. The course was designed primarily for graduates from developed and developing countries with previous training in agriculture, genetics, botany and other related disciplines. Each candidate is carefully assessed on the basis of his qualifications and preference is given to those which are primarily agricultural. The 12-month course is repeated annually and leads to the degree of Master of Science in the University of Birmingham. The course is now in its seventh year.

Even before the First Technical Conference on genetic resources in 1961, FAO had stressed the need for action to prevent the total destruction of germplasm in the centres of genetic diversity and evolution of cultivated plants. The need for funds and concerted action was again stressed at the Second FAO Technical Conference in 1967. It was clearly realised that genetic resources of crop plants and their wild relatives urgently needed to be collected and stored in gene banks as a first essential step in the process of germplasm documentation and its evaluation and utilisation in breeding programmes.

When the FAO Crop Ecology and Genetic Resources Unit was formed in 1968, with a Panel of Experts to advise it on scientific and technical matters, it became clear that no adequate training courses for genetic resources personnel existed in the world at that time. Short field-training courses in some international crop research centres were organised on an ad hoc basis from time to time, and postgraduate studies in crop evolution and the cytogenetics of cultivated plants were available at several universities. It was quite clear, however, that to implement the plans envisaged for the future in this important field a considerable number of scientists with special training in all aspects of genetic conservation would be urgently required. The course at Birmingham was designed, therefore, to provide a thorough training in the theoretical background and practical application of the many diverse activities involved in plant genetic conservation.

The Birmingham course is, therefore, unique and of international significance, even though other academic institutions in several parts of the world have provided, since its inception in 1969, a certain number of options related to genetic conservation. The Birmingham course continues to receive recognition, however, not only from FAO but from many other crop institutes throughout the world. As a result the number of places has increased steadily from an initial five students in 1969/70 to eleven in 1974/75. Demand for places is still increasing but not more than ten or twelve could be provided till 1975, when funds provided by IBPGR allowed the intake to be increased to twenty. Already, in the 1975/76 session numbers have risen to fifteen.

The University of Birmingham has a responsibility to accept a small number of U.K. students on the course, and studentships are provided for these by the British Science Research Council. Nevertheless, the expansion in student numbers will be wholly directed to the developing countries, as is shown in Figure 1, and the small U.K. complement will not affect the philosophy and orientation of the course in any way. By the end of the seventh year, 62 graduates of 27 different nationalities will have received their training. The countries from which graduates have come to Birmingham are shown in Figure 2.

Students have been supported either by their own governments or universities, or by international funds such as FAO fellowships and training awards, the Colombo Plan, the British Council, O.D.A., etc. Some have been seconded from international, regional and national genetic resources centres, research institutes and universities; others have moved straight into this field after taking their first degree at university, fired with enthusiasm at the opportunity of making their careers in genetic conservation.

Although many past students have returned to their own institutes or their own countries, others have gone instead to gene banks or international centres in other countries. Countries to which trained students have gone from Birmingham on completion of their course are shown in Figure 3. The demand for trained personnel in international, regional and national institutes continues to grow steadily.

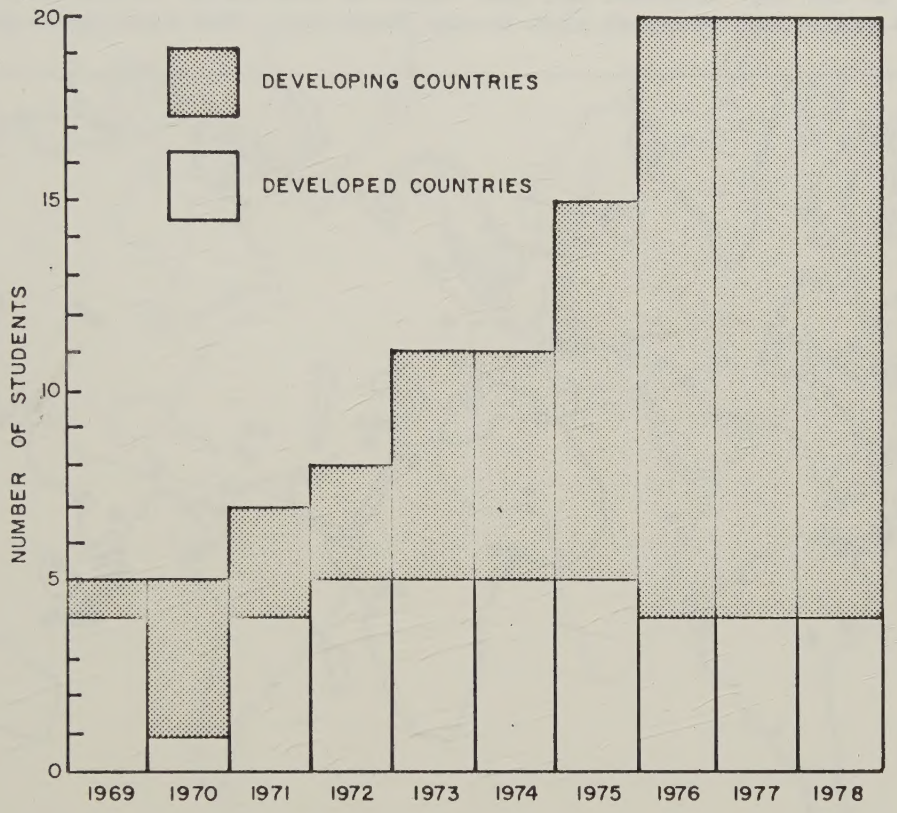

Figure 1 - Student numbers 1969-1975 (1976-1978 - projected)

THE SYLLABUS OF THE COURSE

The Birmingham M.Sc. course aims to cover a wide field, both on the theoretical and practical sides (the syllabus is outlined in a course leaflet published by the University). Some of the lectures are designed to ensure that the genetic basis of variability and crop evolution is thoroughly understood. Others show the range of variation in the major cultivated plants, how they have evolved, and how they are named and classified. The physiological basis of adaptation and productivity related to conditions of climate and soil are also discussed, as well as the physiological and genetic basis of resistance to disease. The evolution of agricultural systems in relation to agricultural origins and crop plant evolution is examined. Forest genetic resources are also considered. Aspects of evaluation and the utilisation of genetic resources in plant breeding are discussed; a course of lectures on plant breeding, and another on case-histories in breeding certain crops, are also included. These

lectures are mostly given by practical plant breeders so that students can be made more fully aware of the practical significance of genetic resources. Students also receive lectures on such practical aspects of genetic conservation as exploration, storage and maintenance of germplasm, either as seed or other material, and documentation and biological statistics. A special course of lectures and seminars is given each year by a member of the Crop Ecology and Genetic Resources Service of FAO.

The year is divided into nine months of lectures, seminars and practical classes followed by three months devoted to a research project, the results of which are presented in the form of a thesis. Throughout the course integration of the component course units is stressed, and this is carried through to the practical project, so that the student becomes familiar with a range of suitable techniques. Although it might be considered that a research project of three months is hardly long enough to provide thorough training in research, experience has shown that this is not so; students are made aware of scientific method much more effectively by carrying out individual research than in any other way. The experience provided by

Figure 2 - Where students have come from to Birmingham.

research is valuable in deciding whether students should be advised to proceed to a Ph.D. degree. Preparatory work for research projects begins at quite an early stage of the course; the students work closely with other post-graduates in the department, and so there is a strong core of people working on various aspects of genetic conservation and crop evolution.

We have had as External Examiners Professors A.H. Bunting, Professor of Agricultural Development Overseas at the University of Reading, P.T. Thomas, Director of the Welsh Plant Breeding Station and E.H. Roberts, Professor of Agriculture at the University of Reading. The External Examiner supervises the theory examinations, conducts individual oral examinations on theses presented by students and comments on the syllabus and structure of the course. The course has also two honorary advisors, Dr. Setijati Sastrapradja, Director of the National Biological Institute of Indonesia at Bogor, and Professor P.T. Thomas, who has been mentioned above.

PROJECT WORK

Although the research project normally has three months' full-time work allocated to it, as we have said above experiments are frequently designed earlier so that material may be obtained and planted in time to be of value when the project begins. As far as possible, projects are designed in collaboration with the Directors of the research institutes from which the students come, and they are encouraged to bring their own plant material.

It is stipulated that the project should involve a cultivated plant (including primitive cultivars) or a wild relative of a cultivated form, and the student is allowed to pursue any topic from the lecture courses that especially interests him. Thus research projects during the first six years of the M.Sc. course have included plant pathology, eco-physiology

Figure 3 - Where students have gone from Birmingham.

(e.g. frost, salt, drought, and temperature tolerance), phytochemistry, genecology, experimental taxonomy, the origin and evolution of cultivated plants utilising cytological, morphological, chemical and numerical taxonomic methods, analysis of provenance data from field collections, tissue-culture maintenance, productivity and growth analysis, seed physiology and seed storage. The range of plant material used in student projects during the first six years of the course is shown in Appendix I.

PRE-M.SC. TRAINING

Practical experience in exploration and gene-bank management cannot be provided in Birmingham. Such training, however, is necessary.

In 1972 and 1973 opportunities were made available for a limited number of students to obtain plant collecting and gene-bank experience for a period of four to six weeks at the Agricultural Research and Introduction Centre at Izmir in Turkey which was directed by Professor V. Tayşi. Similar facilities were provided by the Director of the Germplasm Laboratory at Bari in Italy, Professor E. Porceddu. Students have produced reports on studies resulting from these visits. Copies of these are filed at Izmir or Bari as appropriate, as well as at Birmingham and in the Crop Ecology and Genetic Resources Service of FAO in Rome.

From 1974 onwards these arrangements were extended to the gene-bank at Braunschweig-Völkenrode in the Federal Republic of Germany and the seed-bank at the Royal Botanic Gardens at Kew in the U.K. through the kind collaboration of Professor Hondelmann at Braunschweig and Professor J. Heslop-Harrison and Dr. Peter Thompson at Kew. Plans for expanding these opportunities further are now under way.

POST-M.SC. EXPERIENCE

Students graduating from the M.Sc. course in some cases obtain posts in various crop research institutes; in approved cases others are allowed to continue at the University of Birmingham to carry out research for the degree of Doctor of Philosophy. This is not to mention, of course, those students who, when they graduate, return to the institutes from which they came. Opportunities also exist for some students to carry out research for two years at a crop research centre after an initial period of six months in Birmingham, finally returning to Birmingham for a short period to analyse their results and to prepare their theses. Links of this sort have been established with the International Potato Centre in Peru, the Agricultural Research and Introduction Centre in Turkey, the National Biological Institute in Indonesia, the International Rice Research Institute in the Philippines and the Kitale Agricultural Station in Kenya. Further cooperation with other centres is planned.

THE FUTURE

The Department of Botany at Birmingham will welcome any initiatives that may be taken to promote collaborative links with Genetic Resources Centres in tropical regions as, for instance, in Ethiopia, Costa Rica, Nigeria, and so on. Such links have, in fact, already been established with Indonesia, and pre-M.Sc. training courses, collaborative short-term courses and one- or two-year post-M.Sc. training periods are envisaged.

FAO and the International Board for Plant Genetic Resources have already initiated discussions on important aspects of training on the basis of the Recommendations of the Sixth Meeting of the FAO Panel of Experts (see also Williams, 1975). The Department of Botany offers and invites collaboration with all other interested institutes, and is prepared to expand or modify the post-graduate genetic conservation course, if necessary, to suit future needs and priorities.

Birmingham has almost completed the training of personnel from the Middle East genetic conservation network, according to a plan agreed upon some years ago. For the next five years plans for the training of students for other regional schemes in accordance with FAO and IBPGR requirements and priorities are already being considered.

For the tasks which lie ahead there is no doubt in our minds that many trained personnel will be needed, both from developed and developing countries. The M.Sc. genetic conservation course at Birmingham is one way of fulfilling such a need by providing a training for scientists with enthusiasm and knowledge in a reasonably short space of time.

REFERENCES

Williams, J.T. 1975. Training for genetic resources programmes. in Williams, J.T. and Lamoureux, C.H. (eds.) South East Asian Plant Genetic Resources, Bogor, 254-260.

APPENDIX I - Species used by students in project work, 1969-75

Aegilops bicornis, A. mutica, A. speltoides, A. squarrosa.
Avena abyssinica, A. barbata, A. brevis, A. byzantina, A. canariensis, A. clauda, A. damascena, A. denudata, A. fatua, A. hirtula, A. longiglumis, A. magna, A. nudibrevis, A. pilosa, A. prostrata, A. sativa, A. sterilis, A. strigosa, A. vaviloviana, A. ventricosa, A. wiestii.
Beta maritima, B. vulgaris.
Capsicum annuum, C. baccatum, C. cardenasi, C. chacoense, C. chinense, C. eximum, C. frutescens, C. praetermissum, C. pubescens.
Chloris gayana.
Cicer arietinum.
Citrus grandis.
Elaeis guineensis, E. oleifera.
Lactuca saligna, L. sativa, L. serriola.
Lens culinaris, L. nigricans, L. orientalis.
Linum bienne, L. grandiflorum, L. usitatissimum.
Lycopersicon chilense, L. esculentum, L. glandulosum, L. hirsutum, L. peruvianum, L. pimpinellifolium, L. pissisi.
Momordica balsamina, M. charantia, M. dioica.
Oryza glaberrima, O. nivarra, O. rufipogon, O. sativa, O. spontanea.
Panicum turgidum.
Phaseolus aconitifolius, P. angularis, P. aureus, P. calcaratus, P. lathroides, P. mungo, P. semierectus, P. vulgaris.
Raphanus sativus.
Saccharum barberi, S. maximus, S. officinarum, S. robustum, S. sinense, S. spontaneum.
Secale afghanicum, S. africanum, S. anatolicum, S. ancestrale, S. cereale, S. dighoricum, S. fragile, S. kuprojanovii, S. montanum, S. segetale, S. silvestre, S. vavilovii.
Solanum acaule, S. agrimonifolium, S. ajanhuiri, S. boliviense, S. brevidens, S. chacoense, S. chomatophilum, S. colombianum, S. curtilobum, S. demissum, S. flahaultii, S. immite, S. iopetalum, S. juglandifolium, S. juzcepczukii, S. megistacrolobum, S. microdontum, S. moscopanum, S. multidissectum, S. ochranthum, S. oxycarpum, S. paucijugum, S. pennellii, S. phureja, S. raphanifolium, S. sanctae-rosae, S. santolallae, S. sparsipilum, S. spegazzinii, S. stenotomum, S. toralapanum, S. tuberosum, S. violaceimarmoratum.
Spinacia oleracea.
Sorghum bicolor.
Trigonella foenum-graecum.
Triticum aegilopoides, T. aestivum, T. dicoccoides, T. durum, T. timopheevii.
Vigna sinensis.

RESUME

Les premières six années: formation post-universitaire à Birmingham

L'article présente le cours international de formation donné à Birmingham, Angleterre, dans le domaine de la conservation des ressources génétiques. Ce cours est donné depuis 1969 à un nombre croissant de techniciens qui formeront les cadres du réseau mondial de centres de conservation des ressources génétiques. De ce cours, naissent d'importants relations de cooperation entre Birmingham et les instituts spécialisés à travers le monde.

RESUMEN

Los primevos seis años: entrenamiento de postgrado en Birmingham

Se detalla el curso de entrenamiento internacional en conservación de material vegetal genético que se desarrollo en Birmingham, Reino Unido. Este ha estado en existencia desde 1969, creciendo regularmente en tamaño a fin de proveer la demanda por profesionales en la red global de centros de recursos genéticos. Como resultado, el Departamento de Botánica en Birmingham está desarrollando importantes nexos de collaboración con institutos alrededor del mundo.

Genetic Diversity in Cyprus

by
A. Hadjichristodoulou and A. Della
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INTRODUCTION

Native varieties of winter grain cereals and legumes are still cultivated widely in Cyprus.

In the 1930s 50 durum and 2 aestivum wheat varieties were grown (Anon. 1937). The main varieties, occupying 80 per cent of the wheat area, were the durum varieties Kyperounda, Psathas and Tripolitico. No other durum varieties now exist as varieties but some are still present as off-types in the above three varieties. In isolated farms several indigenous durum lines are still grown. A new breeding programme at the Agricultural Research Institute aims at improving durum wheat by introduction, selection and evaluation of indigenous lines and by hybridisation, mainly of local types, with introduced lines from CIMMYT (Mexico) and Italy. Capeiti 8, an Italian variety, was released in 1972 (Hadjichristodoulou, 1973) and new promising lines are at the final stages of screening.

In the 1930s the main barleys grown were three indigenous varieties, "Exakilon" or Paphitico, "Mavrokritharon" and "Hexastichon" (Anon. 1937). In the early 1960s a new barley variety, Sel B-55-22 was released, but because of its susceptibility to diseases it was withdrawn from cultivation. Today none of the old varieties are grown; instead, 90 per cent of the land under barley is sown with the Greek variety Athenais, introduced in the early 1950s, and the remaining 10 per cent by Attiki, another Greek variety released in 1973. Though thousands of new barley varieties were introduced and tested, none outyielded Athenais. For this reason the barley cross-breeding programme has been expanded recently.

In Cyprus there is only one common vetch (V. sativa) variety, called "local". In the hilly areas where rainfall is higher, common vetch is used for grain and straw production while in the low rainfall central plains it is grown only for grazing or hay making.

Oats and rye were grown in the past (Anon. 1937) but today oats occupy less than 1 per cent of the cereal fields and rye is not grown at all.

Bennett (1973) reported that a remarkable amount of genetic variation is evident in durum wheat varieties in Cyprus. The significance of collecting and conserving the genetic variability in indigenous varieties has been emphasised by many scientists (Frankel, 1973); more important is the utilisation of this genetic variability in breeding programmes.

In 1967 a project was initiated in the Cyprus Agricultural Research Institute in order to study the genetic diversity in indigenous varieties of wheat, barley and common vetch and to use desirable genes in cross-breeding programmes. Three procedures were followed, namely collection of indigenous races, mass selection and pure line selection in commercial varieties. Selections were finally evaluated for morphological, physiological and agronomic characters.

RESULTS

Native durum wheat varieties

The three local commercial varieties, Kyperounda, Psathas and Tripolitico are generally late, tall, and lodging-susceptible. They are not pure varieties; the level of impurities in these varieties depends on the origin of the seed. Farmers' seed contains more off-types

than certified seed. Kyperounda is called "Mavrotheri" (black awns) because its awns turn black at maturity, particularly under good environmental conditions. The three varieties produce amber grains of excellent quality when they are purified.

Psathas is the highest yielding variety under rainfed conditions (Table I). Kyperounda is sown in more fertile fields than Psathas. Tripolitico is mainly grown under spate irrigation in the western part of Cyprus. Psathas is the earliest and Tripolitico has the largest grains. The comparison of these varieties with the Italian durum Capeiti 8 is shown in Table I.

Along with the three main commercial varieties a number of indigenous durum races are grown by a few farmers in small isolated areas. The names of several of these races, selected from all over the island (Figure 1) are given in Table II. Though this list is not complete, it shows nevertheless that several durum races are still grown in Cyprus. The evaluation of the collected populations showed wide variation in agronomic characters such as yield, grain size, volume weight and earliness (Table II). Although some of the populations resemble one of the three main commercial varieties, others are quite different. One such type, Makrokoutsi,

TABLE I

Grain yield and other agronomic characters of local durum varieties compared to the Italian variety Capeiti 8

Variety	Grain yield (kg/ha)	Heading date (days after 1 March)	Plant height (cm)	No. of tillers /m2	Sheaf weight (kg/ha)	Vol. weight (kg/hl)	1,000-grain weight (g)
Capeiti 8	2,044	33	102	222	6,238	82.2	46.3
Kyperounda	1,852	42	112	209	6,662	81.0	40.6
Psathas	1,950	35	108	242	6,652	80.9	41.4
Tripolitico	1,770	40	110	237	6,069	81.7	47.8

(meaning long grains) collected from Panayia produced large grains, had a large spike and broad leaves and it was 30 cm taller than Kyperounda. It has been crossed with Kyperounda and Jori C69 for improvement of grain quality.

Selection within cereal and common vetch varieties

In some varieties, such as Kyperounda durum wheat, the off-types can be distinguished morphologically. The types are well-known to farmers who have named most of them (Skalavatis, Kambourico, Kokkino). In other varieties, however, such as Psathas durum wheat and Athenais and Sel B-55-22 barley, it is more difficult to select morphologically distinct types. In the case of common vetch, seeds can very easily be distinguished into different categories, but the plants are uniform.

Possible sources of genetic variability in commercial varieties are: segregation from the original cross, spontaneous mutations, mechanical mixing, segregation resulting from natural crosses between varieties and inherent instabilities of the plants reproductive system, such as irregularities in meiosis (Jensen, 1965).

Mass selection in Kyperounda

The initial populations in which mass selection was exercised were commercial fields at two locations, at Exo Metokhi and Strovolos. Plants belonging to different morphological types were selected and all the plants of the same type were grouped together and were multiplied in bulk. The agronomic performance of these types was studied in replicated trials during the period 1969-1974. As the populations from the two locations gave similar results, only the data of the selections from Strovolos are discussed in this report.

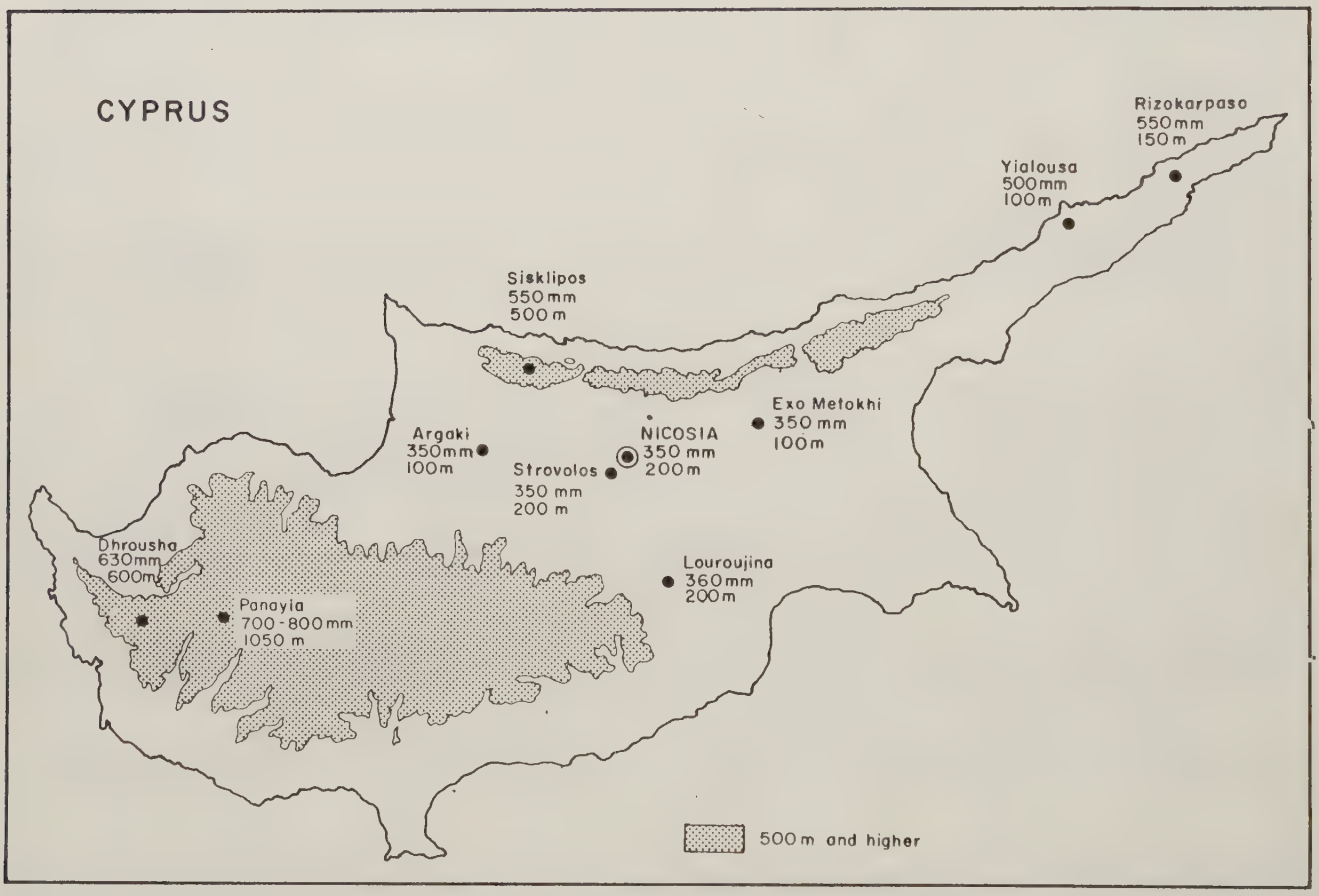

Figure 1 - Cyprus: Sampling sites indicating rainfall and altitude.

Two of the selections, Scalavatis and Hairy Glumes belong to Triticum aestivum, while the other four belong to Triticum durum. The six selections could be distinguished on the basis of colour and shape of leaves and spikes, and other morphological characters. They also showed significant differences in several agronomic characters (Table III). The statistical analysis of the data of each year separately showed that most of the differences among lines were significant at the 5% level of probability. Grain size and volume weight of aestivum types were lower than in durum types. The lines also showed differential response to diseases. Scalavatis and Hairy Glumes were susceptible to leaf rust whereas Long Black Spike, White Spike, Kambourico and Red Spike were resistant. The mother variety Kyperounda showed inter-

mediate reaction to rust. Grain yield of the selections was lower than that of the mother variety. The grain quality of the mother variety can be raised significantly by eliminating the aestivum types because they produce non-vitreous grains.

Pure line selection in cereals

About 150 pure lines originated from single plants were taken at random from each of the commercial varieties of Kyperounda and Psathas durum wheat, and Athenais and Sel B-55-22 barley in 1968. Another 200 progenies of single plants of off-types of Kyperounda were selected in 1970. The seed of pure lines was multiplied. In the subsequent years all the lines were evaluated for yield and other agronomic characters in nurseries, each year discarding the low

TABLE II

Indigenous races of durum wheat

Variety and Location	Grain yield (kg/ha)	1,000-grain weight (g)	Vol. weight (kg/hl)	Heading date (days after 1 March)
Makrokoutsi (Panayia)	695f	39.7a	71.3efg	53.5
Hamira (Louroudjina)	1,083bcde	36.5cd	72.0cdef	51.0
Hamira (Dhrousha)	836cdef	38.5ab	70.8g	52.5
Danielitico or Liaouri (Yialousa, Rizokarpaso)	829def	33.3e	72.7abcd	53.0
A/T Adhrokoutsi (Sisklipos)	739f	36.2d	72.2cdef	53.0
Sofianos (Rizokarpaso)	807ef	36.2d	72.5bcde	52.0
Mavropsathas (Sisklipos)	1,195b	31.0f	73.8a	50.0
Kokkinopsathas (Sisklipos)	1,105bcd	26.7h	71.2fg	49.5
Makrokoutsi (Sisklipos)	829def	37.0cd	72.5bcde	51.5
Kyperounda x 35 Canada (Argaki)	1,120bc	39.0ab	73.0abc	53.5
Papaloizou (Argaki)	1,180b	37.9bc	72.7abcd	52.5
Papaiakovou selection from Kyperounda (Nicosia)	1,322ab	33.7e	73.0abc	51.0
Adhrokoutsi (Kyperounda, Kambourico), Nicosia.	881cdef	36.0d	72.5bcde	51.5
Kyperounda (check)	1,307ab	30.8f	73.0abc	49.5
Psathas (check)	1,210b	30.8f	72.5bcde	44.5

yielding and disease susceptible lines. In 1973/74 replicated yield trials were carried out for the most promising lines. The results varied with variety; in some there was more variability than in others.

(a) Athenais barley. After three years of testing in nurseries, the best 12 lines were compared in replicated trials at two locations for two years. Yield differences were not statistically significant. Also, differences in other characters, such as earliness and plant height were not significant. Athenais, the best commercial barley variety is, perhaps, for practical purposes, a pure variety.

(b) Sel B-55-22 barley. This variety was tested in trials as Athenais. Ten pure lines were evaluated in replicated trials which showed significant differences in grain yield; the yield of pure lines ranged from 4,488 to 5,235 kg/ha. There were also significant differences in heading date (six days) and in plant height (31 cm.) indicating that Sel B-55-22 is not genetically homogeneous. Perhaps genetic segregation is the main source of the observed genetic variability because this variety was released relatively recently, five years before the initiation of the study.

(c) Psathas durum wheat. The comparison of the pure lines from this native variety showed significant differences in grain yield and protein content. Though Psathas is an old variety and more liable to admixtures than modern varieties, the variability for morphological characters was smaller than in native Kyperounda.

TABLE III

Yield and other agronomic characters of Kyperounda selections

Selection	Grain yield Mean of 6 locations (kg/ha)	1,000-grain weight. Mean of 4 locations (g)	Heading date (days after 1 March) Mean of 3 locations	Plant height Mean of 2 locations (cm)	Vitreousness Mean of 3 locations (percent)	Volume weight Mean of 3 locations (kg/hl)
Long Black Spike	1,654	37.7	40.4	83	98.7	78.6
White Spike	1,658	36.7	43.6	83	98.0	78.8
Kambourico	1,634	37.9	43.2	78	98.4	78.3
Red Spike	1,353	36.0	41.7	79	97.6	78.9
Hairy Glumes	1,438	32.4	41.6	84	*	77.4
Scalavatis	1,454	33.5	43.8	76	*	76.2
Kyperounda**	1,759	36.3	43.0	88	97.8	78.0

* lines which produced completely non-vitreous grains
** Mother variety free of aestivum types

(d) Kyperounda durum wheat. The genetic diversity in this variety is the highest among all cereal varieties grown in Cyprus. The number of off-types and their frequency varies with population and it depends mainly on the origin of the seed. Populations grown in small farms in the foothills of the Troodos mountains were more variable than in the main cereal growing regions. The comparison of the pure lines showed significant differences in grain yield, grain size, earliness, plant weight, protein content and disease resistance.

(i) Grain yield. Genetic variability for this important character was significant. Some lines outyielded the base population from which they were selected, while others gave lower yields. The relative yield of the best lines in the replicated

yield trials are given in Table IV. These high-yielding lines are being tested in various agroclimatic zones. All selected lines are durum types and can be distinguished morphologically.

(ii) Grain size. The 1,000-grain weight of Kyperounda was 37 g. and that of the pure lines ranged from 30 g. to 44.8 g. The 1,000-grain weight of the high yielding lines KMS 70-63 and KMS 70-88 (Table IV) was 42.8 and 43.8 g. respectively, and significantly higher than that of Kyperounda.

(iii) Earliness. Small, but statistically significant differences in heading date were found among the Kyperounda pure lines. The line PLSK-68-54 was 6.5 days earlier whereas PLSK-68-73 was four days later than Kyperounda. Line KMS 70-63 was two days later whereas all other varieties in Table IV were one to seven days earlier than Kyperounda.

(iv) Plant height. The plant height of pure lines ranged from 93 to 114 cm; Kyperounda was 99 cm. tall.

(v) Protein content. Pure lines were variable in protein also (Hadjichristodoulou and Della, 1973). In one group of lines percent protein content ranged from 15.7 to 18.6. Protein content of Kyperounda was 17.8 percent.

(vi) Diseases. Reaction of pure lines to rust ranged from complete resistance to complete susceptibility.

Pure line selection in common vetch.

Plants of common vetch appeared uniform from seedling to maturity stages. Seeds, however, were variable in shape and colour. Studies with pure lines on seed characters showed that some lines were true-breeding while others were segregating for seed colour and shape. Six true-breeding lines producing seeds of distinct colour and shape are under multiplication. Uniformity of seed colour and shape is required by the market. The segregating lines will be studied further.

In the 1972/73 season a nursery was sown for comparing grain yield and protein content of grain of 67 pure lines of common vetch, with the mother variety as check. Percent protein content of the mother variety ranged from 28 to 32 and that of the pure lines from 28 to 36. The high protein lines will be further tested in replicated trials.

DISCUSSION AND CONCLUSIONS

Though a considerable portion of genetic variability in field crops grown in Cyprus has been lost by genetic erosion, large amounts of adaptive genetic diversity were conserved, mainly in the commercial varieties. The genetic variability found was either phenotypically expressed or hidden as cryptic genetic variability. Cryptic variability was detected by certain experimental techniques such as induced disease epidemics for disease reaction and replicated yield trials for yield potential. Bennett (1970) emphasised that the adaptive response of populations with cryptic genetic variability is high. The most widely cultivated durum variety in Cyprus, Kyperounda, has shown large amounts of both phenotypic and cryptic genetic variability. This variety has been grown successfully on various soil types and under a variety of rainfall conditions, perhaps for centuries. The wide adaptability of Kyperounda is probably due to its genetic heterogeneity. In general, genetically heterogeneous populations express higher stability under varying environmental conditions than homogeneous populations (Allard, 1961). Under the fluctuating environment of Cyprus a composite variety made up from the highest yielding pure lines in Table IV, and which have similar agronomic characters (earliness, quality, height, etc.), could be more stable than a single pure line.

Genetic variability, if not completely useful at present, is potentially useful for the future. The present studies showed that useful genotypes could be selected from indigenous populations and could be used either as new varieties or as parents in cross-breeding programmes.

One easy way to conserve indigenous races would be to avoid drastic selection pressures aiming at high varietal purity. Plant types such as Scalavatis and Hairy Glumes, which produce non-vitreous kernels, should be eliminated from the durum populations of Kyperounda because of inferior quality. Other plant types, however, which when maintained in the variety show no adverse effect on its performance, should not be selected against because they enhance stability, and they could be exploited in the future.

In the last 30 years a large number of new high yielding wheat varieties were introduced in countries all over the world and breeders quickly replaced old native varieties with new modern varieties. Most of these modern varieties were developed in centres like CIMMYT, Mexico, and are often unrelated genetically to indigenous genetic variability, adapted to local conditions. The possibility of selecting new high-yielding lines from the indigenous

TABLE IV

Relative yield of selected high yielding pure lines of Kyperounda durum wheat

Line	Relative yield (Mean of two years) - Kyperounda = 100
KMS 70-20	129
KMS 70-63	130
KMS 70-88	123
KMS 70-123	130
KMS 70-161	136
KMS 70-164	118

varieties has been shown by this study. Therefore, local populations should be investigated carefully before being replaced. Selections from indigenous varieties, adapted to the agroclimatic conditions of a country could be superior to the original variety or to modern varieties.

ACKNOWLEDEMENTS

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SUMMARY/RESUME/RESUMEN

The range of genetic diversity present in indigenous and commercial varieties of durum wheat, barley and common vetch in Cyprus is examined. Collections and mass - and pure-line - selections are evaluated for a number of morphological, physiological and agronomic characteristics. Genetic variability reflected in significant differences varies with crop variety, and geographical region, and in the case of Kyperounda wheat particularly, is unevenly distributed. It affects many plant characters including grain yield, grain size, earliness, plant height, protein content and disease resistance. It is concluded that the large reserves of genetic variability in Kyperounda wheat not only contribute to the high adaptability of this variety but may provide useful parental material for future breeding programmes.

Diversité génétique à Chypre

Le degré de diversité génétique dans les variétés indigènes de blé dur, orge et vesce commune a été étudié dans des collections, sélections massales et de lignées pures. Cette étude portant sur un certain nombre de caractères morphologiques, physiologiques et agronomiques a montré une grande diversité en fonction de la culture, de la variété et la région d'origine. Spécialement dans la variété de blé dur Kyperounda, il semble que la variabilité génétique soit distribuée de manière inégale. Beaucoup de caractères de la plante sont affectés entre autres, la productivité, la taille des graines, la précocité, la hauteur de la culture, le contenu protéique et la résistance aux maladies. La grande variabilité génétique de la variété Kyperounda est probablement responsable de son adaptabilité remarquable. De plus cette variété constitue un matériel très intéressant pour les futurs programmes de sélection.

Diversidad Genética en Chipre

El rango de diversidad genética en variedades indigenas de trigo durum, cebada y Vicia común en Chipre, ha sido investigado en colecciones, selecciones masales y selecciones de lineas puras, en cuanto a un número de caracteres morfológicos, fisiológicos y agronómicos, encontrándose que varian con el cultivo, variedad y la región geográfica de origen. Especialmente en el caso de la variedad de durum Kyperounda, la variabilidad genética está irregularmente distribuida. Muchos caracteres de la planta son afectados, entre ellos el rendimiento en grano, tamaño de la semilla, precocidad, altura de la planta, contenido en proteinas y resistencia hacia las enfermedades. Las grandes reservas de variabilidad genética en trigo Kyperounda probablemente no solo cuenta para su alta adaptabilidad, sino tambien provee util material padre para futuros programas de mejoramiento.

* * * * *

BOOK REVIEW

Zeven, H.C. and Zhukovsky, P.M. 1975, Dictionary of cultivated plants and their centres of diversity: excluding ornamentals, forest trees and lower plants. Wageningen, Centre for Agricultural Publishing and Documentation; pp. 224; 109 maps; cloth-bound; price DFL 45.00.

For those of us who were brought up on Uphof and Sturtevant, the "Dictionary of Cultivated Plants and their Centres of Diversity" by A.C. Zeven and P.M. Zhukovsky is a welcome change. The book incorporates the significant work of Zhukovsky on gene centres with a review of earlier work by de Candolle, Vavilov, Harlan and others. In 1968 and 1970 Zhukovsky suggested that since so many crops originated outside Vavilov's "centres of origin" it was necessary to enlarge the areas of these and increase the number, making 12 "megacentres". Three of these are new, and some original boundaries have been redefined. Each species entry provides an English vernacular name, chromosome number if known, and notes on distribution, origin and cultivation. It is a pity that the entries are so short, especially in cases where doubts exist about the origin and evolution of the crop. To cite the example of rice, it is not clear what exactly is meant by Oryza rufipogon and O. perennis (anyway a nomen ambiguum); and the hybrid spontanea is not stated clearly to be a cross between the cultivated and wild species. Similarly, both O. longistaminata and O. perennis are considered synonymous for the wild perennial rice plants in Africa, though still cited separately in this book.

The dictionary explicitly aims to exclude ornamentals, forest trees and lower plants, and indeed the sub-title of the book states this. Nevertheless, some obvious ornamentals are included. Although more than 2,000 species are listed altogether and one welcomes this addition, some crop treatments are incomplete. This is especially so in the case of tropical fruits where frequently only the more important cultivated species are mentioned. For example, in the case of mangoes only half of the number of species cultivated are listed. Many species show limited distribution within their gene centre, and it would be useful to know this as in the case of Mangifera oderata, which is cultivated centrally in the Indo-Chinese-Indonesian centre, though not in the Malay Peninsula nor the Philippines, in contrast with M. indica which is cultivated throughout the centre and as far east as the Solomon islands. M. timorensis is another cultivated species which is limited to a small area in the east of this gene centre which should also be listed. The same comments can apply to many other species.

The case of rice and of the tropical fruits cited above suggests that the book's major weakness lies in its treatment of tropical crops. We see the dictionary essentially as a "first go" and will certainly stimulate much interest and discussion. We hope that in future editions revisions of the weaknesses we have cited will be made. Even as it stands, however, this work will be an invaluable guide to those interested in the origins of cultivated plants and plant genetic resources and should occupy space in all agricultural libraries. The work is in many respects unique and deserves to be widely read.

J.T.W.

Note:

It is with very deep regret that we learn of the death of Professor Zhukovsky. He was an early and life-long collaborator of N.I. Vavilov and is well-known throughout the world for his outstanding contributions on the genetic diversity of cultivated plants. His death is a very serious loss. In the next issue of Plant Genetic Resources a full obituary will be published.

* * * * *

EVALUATING A PISUM COLLECTION

by
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INTRODUCTION

The importance of pea as a protein source for man is apparent from data on its acreage and production. Peas are grown all over the world in temperate and sub-tropical regions, and cover an area of about seven million hectares, producing more than ten million tons annually. In India, the corresponding figures are about one million hectares and about eight thousand tons.

One of the useful and important services which a Plant Introduction Organisation can render to plant scientists is to maintain and evaluate germplasm and disseminate information, so that the germplasm can be effectively utilised in breeding or genetical studies. The Plant Introduction Division at the Indian Agricultural Research Institute, New Delhi provides this service through its quarterly publication "Plant Introduction Reporter", and through publications in other journals.

In recent years a collection of field pea (Pisum sativum sub-sp. arvense Poir) totalling 628 accessions was made from important pea growing regions within the country. This material has been evaluated with regard to fifteen plant, pod and seed characters. Information regarding the evaluation of this collection is presented in the present series of papers.

Each accession was grown in a single row 2m. long, spaced 0.75m. apart. Seeds were dibbled at 15cm. spacing. Five random plants in each accession were scored for various characters over three years. These values were then averaged for each character. Characters are listed, and values classified, by number for presentation, as indicated below.

1. Days to flower: Number of days taken from the date of sowing to the production of first flower (fully opened) was recorded. This trait not only indicates the duration of vegetative phase but is also related to maturity. Six categories were made for grouping the collection:

Those which flowered in 45 days	- 1	Between 66 and 75 days	- 4
Between 46 and 55 days	- 2	Between 76 and 85 days	- 5
Between 56 and 65 days	- 3	More than 85 days	- 6

2. Node of first blossom: This is an important varietal character and has been used in classification of varieties. It has also been reported to give a fair idea regarding earliness or lateness of a genotype, the early ones flowering at a low node. The following five categories were used for this trait:

Up to 10th node	- 1	21st to 25th node	- 4
11th to 15th node	- 2	Above 25th node	- 5
16th to 20th node	- 3		

3. Foliage colour: This character is influenced to some extent by soil and environmental factors. Nevertheless varietal differences under the same conditions are exhibited. The collection was put into four groups:

Green	- G	Dark green	- DG
Bluish green	- BG	Showing purplish tinge	- PG

4. Number of productive branches: In the material evaluated, genotypes ranged from single-stemmed (no branching) to those producing ten or more branches. This is an important yield-contributing character. The collection was grouped into five categories:

Single stemmed	- 1	7 to 10 branches	- 4
2 or 3 branches	- 2	More than 10 branches	- 5
4 to 6 branches	- 3		

5. Plant height (cms.): A very wide range in the height was observed in the germplasm evaluated. It was measured from the ground level to the tip of the plant when plants were fully mature. It is associated with yield and is used as a distinguishing character. Some workers use the vague terms such as tall, medium-tall and dwarf to describe the varieties. The collection was divided into the following five groups:

Up to 30cm. tall	- 1	91 to 120cm. tall	- 4
31 to 60cm. tall	- 2	More than 120cm. tall	- 5
61 to 90cm. tall	- 3		

6. Flower colour: Though the most common colour is white, varieties are met with which have pink, purple or violet flowers. This character is also used for varietal identification. Three main colours were observed in the collection:

White - W Pink - P Purple - Pl

7. Pod length (cm.): From the basal end to the tip of the pod was measured for this character. It is fairly constant on the same plant. A wide range of variation was observed in the collection. Four groups were made for classifying:

Up to 50mm. long	- 1	71 to 90mm. long	- 3
51 to 70mm. long	- 2	More than 90mm. long	- 4

8. Shape of pod: Genotypes are characterised by the shape of pods. Three categories were made for grouping the collection:

Straight pod - S Bent pod - B Sickle-shaped pod - Sic.

9. Number of pods per peduncle: No variety is strictly single-podded or double-podded. It may be said to be predominantly single, or double podded. A few varieties have been released which have three or more pods per peduncle. This character is directly associated with yield and as such is an important trait. The collection was grouped into three classes:

Predominently single podded	- 1
Mainly double podded	- 2
Three or more pods per peduncle	- 3

10. Number of pods per plant: This character is of particular interest to plant breeders as it is directly associated with seed yield. It is influenced by agronomic and cultural practices, but a genotype which under ordinary conditions bears, for example, 10 pods can not be expected to produce 30 or 40 pods under intensive cultivation. Six categories were made to classify the collection:

Up to 10 pods	- 1	From 41 to 70 pods	- 4
From 11 to 20 pods	- 2	From 71 to 100 pods	- 5
From 21 to 40 pods	- 3	More than 100 pods	- 6

11. Number of seeds per pod: This is a constant character and is governed by the length of pod and seed size. It is also an important yield-contributing character. The collection was grouped into five classes:

Up to 3 seeds	- 1	8 to 9 seeds	- 4
4 to 5 seeds	- 2	More than 9 seeds	- 5
6 to 7 seeds	- 3		

12. Seed colour: A great variation in colour of ripe seed in field pea is observed. Yellow-seeded varieties are generally preferred for soup while green-seeded types are used for canning. Both types are used for cooking whole pea. The entire collection was divided into the following eight categories. In the mottled group, the first colour indicates the basal colour:

Yellow	- Y	Chocolate	- C
Greenish yellow	- GY	Chocolate mottled	- CM
Green	- G	Green chocolate	- GC
Green mottled	- GM	Bluish mottled	- BM

13. Shape of seed: In field pea the seed is either round or dimpled (slight depression), but some genotypes exhibit irregular shape also. The collection was divided into appropriate categories, as follows:

Round	- R	Dimpled	- D	Irregular	- I

14. Colour of hilum: A genotype is characterised by its hilum colour. The collection was divided into the following three groups:

White	- W	Black	- Bl	Brown	- Br

15. 100-seed weight: Two samples from the bulk were taken and weighed on an electric balance. Actual average figures are given here.

In the catalogue, the first column gives the serial number, the second is for the accession number given to each collection as and when received. The symbol PLP denotes the material collected under a PL-480 Project which functioned at this Division from 1965 to 1970. I.C. denotes the indigenous cultivated. The name of the variety, if any, and the source of procurement or collection are given in the succeeding columns, mentioning the name of the State (U.P. = Uttar Pradesh, M.P. = Madhya Pradesh, H.P. = Himachal Pradesh).

* * * * *

SUMMARY

The evaluation of a large germplasm collection of Pisum sativum for 15 characters is reported. This is the first part of a report which will be continued in later issues of Plant Genetic Resources.

RESUME

Evaluation d'une collection de Pois

L'article présente la première partie d'une rapport d'évaluation d'une collection mondiale de Pisum sativum à propos de 15 caractères génétiques et agronomiques.

RESUMEN

Evaluación de una colección de Pisum

Esta es la primera parte de un informe sobre la evaluación de una colección mundial de germoplasma de Pisum sativum para quince caracteres genéticos y agronómicos.

PEAS: YELLOW-SEEDED

Sample number	Accession number	Name of variety	Source	Days to flower	Node of 1st flower	Colour of leaf	Number of productive branches	Height of plant	Colour of flower
				1	2	3	4	5	6
1		Alfer		1	2	BG	2	4	W
2	PLP 1		Mahar-astra	6	3	BG	3	5	W
3	2		U.P.	4	2	BG	4	5	W
4	4	BR 12	Bihar	6	4	BG	4	4	W
5	8	BR 2	Bihar	5	3	BG	5	4	W
6	11		U.P.	6	3	BG	4	5	W
7	12		U.P.	5	3	BG	5	5	W
8	13	T.61	U.P.	5	3	BG	3	5	W
9	15		U.P.	6	3	BG	3	4	W
10	16		U.P.	5	3	BG	2	4	W
11	17		U.P.	6	3	BG	3	5	W
12	18		U.P.	6	3	BG	4	5	W
13	19		U.P.	5	3	BG	5	5	W
14	20		U.P.	6	3	BG	2	4	W
15	21		U.P.	5	2	BG	3	4	W
16	23		U.P.	5	2	BG	3	4	W
17	24		U.P.	5	3	BG	4	5	W
18	25		U.P.	4	2	BG	3	4	W
19	26		U.P.	6	3	BG	3	3	W
20	27		U.P.	5	2	BG	5	5	W
21	28		U.P.	5	2	BG	3	3	W
22	29		U.P.	5	3	BG	5	4	W
23	42		U.P.	5	3	BG	3	4	W
24	45A		U.P.	6	4	BG	4	5	W
25	46		U.P.	6	3	BG	4	5	W
26	48		U.P.	4	3	BG	4	4	W
27	50		U.P.	5	2	BG	5	4	W
28	51		U.P.	6	4	BG	4	5	W
29	54		U.P.	5	3	BG	4	5	W
30	54A		U.P.	5	3	BG	5	5	W
31	55		U.P.	5	3	BG	3	4	W
32	62		U.P.	6	3	BG	4	5	W
33	64A		U.P.	6	3	BG	3	4	W
34	66		U.P.	5	2	BG	4	5	W
35	67		U.P.	5	3	BG	3	4	W
36	68		U.P.	4	2	BG	3	4	W
37	69		U.P.	5	3	BG	5	4	W
38	71		U.P.	6	3	BG	5	4	W
39	75		U.P.	6	3	BG	4	5	W

Length of pod	Shape of pod	Number of pods/ peduncle	Number of pods/ plant	Seeds/ pod	Colour of ripe seed	Shape of seed	Colour of hilum	100-grain weight (gm.)
7	8	9	10	11	12	13	14	15
2	S	1	3	3	Y	R	W	18.5
2	S	1	4	2	Y	R	W	12.0
1	S	2	5	1	Y	R	W	12.0
3	S	2	4	2	Y	R	Bl	19.0
2	S	2	6	1	Y	R	W	14.5
2	S	2	5	2	Y	R	W	9.0
2	S	2	5	1	Y	R	W	8.5
2	S	1	3	1	Y	R	W	14.0
2	S	2	3	2	Y	R	W	12.0
2	S	2	2	2	Y	D	W	7.0
2	S	2	4	2	Y	R	W	11.0
2	S	1	3	1	Y	R	Bl	10.0
2	S	1	5	2	Y	R	W	10.0
2	S	1	2	2	Y	R	W	9.0
2	S	1	3	2	Y	R	W	4.0
2	S	1	3	1	Y	R	W	9.0
2	S	2	4	2	Y	R	W	9.5
2	S	1	3	2	Y	R	W	11.0
2	S	1	3	1	Y	R	W	7.0
2	S	1	4	2	Y	R	W	12.0
1	S	1	3	1	Y	R	W	9.0
2	S	2	5	2	Y	R	W	11.0
2	B	2	3	2	Y	R	W	12.5
2	S	2	3	1	Y	R	W	10.5
1	S	2	4	1	Y	R	W	9.5
1	S	1	4	2	Y	R	W	10.0
2	S	2	4	2	Y	R	W	12.0
2	S	2	4	2	Y	R	W	11.0
2	S	2	4	2	Y	R	Br	11.0
2	S	1	4	2	Y	R	W	11.5
2	S	2	3	2	Y	R	W	17.0
2	S	2	4	2	Y	R	W	10.5
1	S	2	4	1	Y	R	W	12.0
1	S	1	3	2	Y	R	W	9.0
2	S	2	4	2	Y	R	W	15.0
2	S	2	4	1	Y	R	W	9.5
1	S	2	6	2	Y	R	W	9.0
2	S	2	5	2	Y	R	W	12.0
2	S	2	3	2	Y	R	W	12.0

Sample number	Accession number	Name of variety	Source	Days to flower	Node of 1st flower	Colour of leaf	Number of productive branches	Height of plant	Colour of flower
				1	2	3	4	5	6
40	PLP 76		U.P.	5	2	BG	4	5	W
41	77		U.P.	6	3	BG	3	5	W
42	79		U.P.	6	3	BG	3	5	W
43	84		U.P.	5	3	BG	3	4	W
44	88		Rajasthan	6	4	BG	4	3	W
45	89		Rajasthan	5	3	BG	3	4	W
46	90		Rajasthan	5	3	BG	3	4	W
47	90A		Rajasthan	6	3	BG	4	3	W
48	92		Rajasthan	6	2	BG	5	4	W
49	93		Rajasthan	6	2	BG	4	4	W
50	94		Rajasthan	6	3	BG	2	4	W
51	95		Rajasthan	6	2	BG	3	4	W
52	96		Rajasthan	6	3	BG	4	5	W
53	97		Rajasthan	5	2	BG	5	4	W
54	97A		Rajasthan	5	2	BG	3	5	W
55	98		Rajasthan	6	3	BG	4	4	W
56	102		Rajasthan	6	3	BG	3	5	W
57	103		U.P.	5	2	BG	2	5	W
58	104		U.P.	6	3	BG	3	5	W
59	104A		U.P.	6	3	BG	3	5	W
60	105		U.P.	5	2	BG	3	5	W
61	106		H.P.	6	2	BG	4	4	W
62	107		H.P.	5	2	BG	3	4	W
63	109		H.P.	6	3	BG	4	4	W
64	113		H.P.	6	3	BG	4	4	W
65	118		Punjab	6	3	BG	3	4	W
66	125		Rajasthan	5	2	BG	3	3	W
67	126		Punjab	5	2	BG	3	4	W
68	127		Punjab	6	3	BG	4	4	W
69	130		Punjab	6	2	BG	4	4	W
70	137		U.P.	5	2	BG	3	5	W
71	138		U.P.	6	3	BG	4	5	W
72	148		Punjab	6	3	BG	3	5	W
73	154		H.P.	6	3	BG	4	4	W
74	155		H.P.	6	4	BG	3	5	W
75	164		U.P.	5	2	BG	3	4	W
76	165		U.P.	6	3	BG	3	5	W
77	169		Bihar	5	2	BG	3	5	W
78	171		Rajasthan	5	5	BG	3	4	W

Length of pod	Shape of pod	Number of pods/ peduncle	Number of pods/ plant	Seeds/ pod	Colour of ripe seed	Shape of seed	Colour of hilum	100-grain weight (gm.)
7	8	9	10	11	12	13	14	15
1	S	2	4	2	Y	R	W	12.0
2	S	2	4	2	Y	R	W	10.0
1	S	2	3	1	Y	R	Bl	10.0
1	S	1	3	1	Y	R	W	10.5
1	S	2	3	2	Y	R	W	14.0
1	S	2	4	2	Y	R	W	12.0
2	B	2	3	1	Y	R	W	12.0
2	S	2	4	2	Y	R	W	11.0
1	S	2	6	2	Y	R	W	8.0
1	S	1	2	2	Y	D	W	10.0
2	S	1	3	2	Y	R	W	10.0
1	S	1	3	2	Y	R	W	7.0
2	S	2	4	2	Y	R	W	12.0
1	S	2	5	2	Y	R	W	9.0
2	S	2	3	2	Y	R	W	10.0
1	S	2	3	1	Y	R	W	12.0
1	S	2	3	2	Y	R	W	11.0
1	S	2	3	2	Y	R	W	11.0
1	S	2	3	1	Y	R	W	12.0
1	S	2	3	2	Y	R	W	12.0
1	S	2	4	2	Y	R	W	10.0
1	S	1	2	2	Y	R	W	8.0
1	S	1	2	1	Y	D	W	9.0
1	S	2	4	2	Y	R	W	13.0
1	S	2	3	2	Y	R	W	9.0
1	S	2	3	2	Y	R	W	10.0
1	S	1	3	2	Y	R	W	8.0
2	S	1	3	2	Y	R	W	7.0
2	S	2	4	2	Y	R	W	13.0
1	S	2	4	1	Y	R	W	11.0
1	S	2	4	1	Y	R	Bl	11.0
1	S	2	3	1	Y	R	Bl	10.5
2	S	2	4	2	Y	R	W	12.0
1	S	1	4	2	Y	R	W	10.0
1	S	2	3	2	Y	R	Bl	10.0
2	S	1	3	2	Y	R	W	10.0
2	S	2	4	2	Y	R	W	12.0
1	S	2	4	2	Y	R	W	11.0
2	S	1	4	2	Y	D	W	12.0

Sample number	Accession number	Name of variety	Source	Days to flower	Node of 1st flower	Colour of leaf	Number of productive branches	Height of plant	Colour of flower
				1	2	3	4	5	6
79	PLP 172		Rajasthan	5	2	BG	4	5	W
80	173		Punjab	6	3	BG	2	5	W
81	176		Rajasthan	5	2	BG	3	5	W
82	177		Rajasthan	5	3	BG	2	4	W
83	179		Rajasthan	5	2	BG	4	4	W
84	179A		Rajasthan	5	2	BG	4	4	W
85	180		Rajasthan	5	2	BG	3	4	W
86	182		Rajasthan	5	2	BG	3	4	W
87	184		Rajasthan	4	3	BG	3	4	W
88	185		Rajasthan	4	2	BG	4	5	W
89	186		Rajasthan	3	2	BG	3	4	W
90	188		Rajasthan	5	2	BG	5	5	W
91	189		Haryana	5	3	BG	3	4	W
92	190		Haryana	5	3	BG	4	5	W
93	191		Haryana	5	2	BG	4	5	W
94	192		Haryana	6	4	BG	4	4	W
95	194		U.P.	5	2	BG	3	5	W
96	195		Haryana	6	3	BG	3	5	W
97	197		Haryana	6	3	BG	3	3	W
98	198		Haryana	5	2	BG	4	5	W
99	199		Haryana	6	4	BG	3	4	W
100	201		Haryana	6	4	BG	3	4	W
102	202		Haryana	4	2	BG	5	5	W
103	203		Haryana	6	3	BG	4	3	W
104	206		Haryana	5	2	BG	4	5	W
105	207		Haryana	6	3	BG	5	5	W
106	208		Punjab	6	4	BG	3	4	W
107	209		Punjab	6	3	BG	4	5	W
108	211		U.P.	6	3	BG	4	4	W
109	212		U.P.	6	4	BG	3	4	W
110	213		U.P.	6	3	BG	5	5	W
111	216		U.P.	6	3	BG	2	4	W
112	217		U.P.	6	3	BG	3	4	W
113	218		U.P.	6	3	BG	4	4	W
114	219		U.P.	6	3	BG	4	5	W
115	221		U.P.	6	4	BG	4	4	W
116	222		U.P.	5	3	BG	5	5	W
117	223		U.P.	6	4	BG	4	5	W
118	224		U.P.	6	4	BG	3	5	W
119	226		U.P.	5	3	BG	4	5	W

Length of pod	Shape of pod	Number of pods/ peduncle	Number of pods/ plant	Seeds/ pod	Colour of ripe seed	Shape of seed	Colour of hilum	100-grain weight (gm.)
7	8	9	10	11	12	13	14	15
1	S	2	4	2	Y	R	W	12.0
2	S	2	3	2	Y	R	W	12.0
1	S	1	3	2	Y	R	W	9.0
2	S	1	2	2	Y	R	W	11.0
1	S	1	3	2	Y	R	W	8.0
1	S	1	4	1	Y	R	W	7.0
2	S	1	3	2	Y	R	W	8.0
3	S	1	3	1	Y	R	W	13.0
1	S	1	3	2	Y	R	W	10.0
1	S	1	4	2	Y	R	W	9.5
1	S	2	4	2	Y	R	W	9.0
2	S	1	4	2	Y	R	W	11.0
1	S	1	3	1	Y	R	W	9.0
2	S	2	3	2	Y	R	Bl	12.0
1	S	1	3	2	Y	R	W	10.5
1	S	2	4	2	Y	R	W	11.0
2	S	2	4	2	Y	R	Bl	9.5
1	S	2	3	2	Y	R	W	12.0
1	S	1	3	2	Y	R	W	14.0
2	S	2	3	2	Y	R	W	15.0
2	S	2	3	2	Y	R	W	12.5
2	S	2	3	2	Y	R	W	13.0
1	S	1	5	2	Y	R	W	11.0
2	S	2	3	2	Y	R	W	13.0
2	S	1	2	1	Y	R	W	10.0
2	S	2	3	2	Y	R	W	13.0
2	S	2	4	2	Y	R	W	12.0
2	S	2	4	2	Y	R	W	11.5
2	S	2	2	1	Y	R	W	12.0
2	S	2	1	1	Y	R	W	15.0
2	S	2	4	2	Y	R	W	12.0
2	S	2	3	1	Y	R	W	12.5
2	S	2	4	2	Y	R	W	12.0
2	S	2	3	2	Y	R	W	14.0
2	S	2	3	2	Y	R	W	12.0
2	S	2	4	2	Y	R	W	12.0
2	S	2	4	2	Y	R	W	13.0
2	S	2	3	2	Y	R	W	13.0
2	S	2	3	2	Y	R	W	11.0
1	S	1	3	2	Y	R	W	10.0

Sample number	Accession number	Name of variety	Source	Days to flower	Node of 1st flower	Colour of leaf	Number of productive branches	Height of plant	Colour of flower
				1	2	3	4	5	6
120	PLP 226A		U.P.	6	4	BG	4	5	W
121	227		U.P.	6	3	BG	5	4	W
122	228		U.P.	6	3	BG	3	5	W
123	229		U.P.	6	3	BG	4	5	W
124	230		U.P.	6	3	BG	4	5	W
125	232		U.P.	6	3	BG	3	5	W
126	233		U.P.	6	3	BG	4	5	W
127	234		U.P.	6	4	BG	2	5	W
128	235		U.P.	5	4	BG	3	5	W
129	236		U.P.	6	4	BG	3	5	W
130	237		U.P.	5	2	BG	4	5	W
131	238		U.P.	5	3	BG	4	5	W
132	243		U.P.	6	3	BG	4	5	W
133	247		U.P.	6	4	BG	4	5	W
134	248		U.P.	5	3	BG	2	5	W
135	250		U.P.	6	2	BG	3	5	W
136	251		U.P.	5	3	BG	4	5	W
137	253		U.P.	6	3	BG	3	5	W
138	257		U.P.	5	2	BG	5	5	W
139	259		U.P.	6	1	BG	4	5	W
140	261		U.P.	6	3	BG	4	5	W
141	263		U.P.	6	3	BG	3	5	W
142	265		U.P.	6	3	BG	3	5	W
143	266		U.P.	5	2	BG	4	3	W
144	266A		U.P.	5	3	BG	4	5	W
145	268		U.P.	5	3	BG	3	4	W
146	268A		U.P.	6	4	BG	3	4	W
147	270		U.P.	6	3	BG	4	4	W
148	275		U.P.	5	3	BG	4	5	W
149	278		U.P.	5	3	BG	5	5	W
150	279		U.P.	5	3	BG	5	5	W
151	282		U.P.	5	2	BG	4	5	W
152	283		U.P.	6	4	BG	4	5	W
153	284		U.P.	5	3	BG	3	5	W
154	287		U.P.	4	2	BG	5	5	W
155	288		U.P.	5	2	BG	3	5	W
156	290		U.P.	4	2	BG	4	4	W
157	291		U.P.	5	2	BG	3	4	W
158	293		U.P.	4	2	BG	4	4	W
159	298		U.P.	5	2	BG	4	4	W

Length of pod	Shape of pod	Number of pods/ pedunole	Number of pods/ plant	Seeds/ pod	Colour of ripe seed	Shape of seed	Colour of hilum	100-grain weight (gm.)
7	8	9	10	11	12	13	14	15
1	S	1	5	1	Y	R	W	11.0
2	S	2	1	2	Y	R	W	12.0
2	S	2	4	2	Y	R	W	11.0
2	S	2	4	1	Y	R	W	12.0
2	S	2	3	1	Y	R	W	12.0
2	S	2	3	2	Y	R	W	9.0
2	S	2	3	1	Y	R	W	13.0
2	S	2	3	1	Y	R	W	13.0
1	S	2	3	2	Y	R	W	12.0
2	S	2	2	2	Y	R	W	12.0
2	S	2	3	2	Y	R	W	11.0
2	S	2	3	2	Y	R	W	10.0
1	S	2	3	2	Y	R	W	8.0
2	S	2	3	2	Y	R	W	12.0
2	S	2	2	2	Y	R	W	11.0
2	S	2	3	2	Y	R	W	12.0
1	S	2	4	2	Y	R	W	12.0
2	S	2	3	2	Y	R	W	13.0
2	S	2	3	1	Y	R	W	12.0
1	S	2	3	2	Y	R	W	12.0
2	S	2	2	2	Y	R	W	11.0
2	S	2	2	2	Y	R	W	9.0
2	S	2	3	2	Y	R	W	11.5
2	S	2	2	2	Y	R	W	13.0
2	S	2	4	2	Y	R	W	12.0
2	S	2	2	2	Y	R	W	12.0
2	S	2	1	2	Y	R	W	16.0
2	S	2	3	2	Y	R	W	12.0
2	S	2	4	2	Y	R	W	11.0
2	S	2	4	2	Y	R	W	12.0
1	S	2	3	1	Y	R	W	7.0
2	S	2	3	2	Y	R	W	12.5
2	S	2	3	2	Y	R	W	12.0
2	S	2	4	2	Y	R	W	13.0
2	S	2	4	2	Y	R	W	10.0
1	S	2	3	2	Y	R	W	10.0
2	S	2	4	2	Y	R	W	12.0
1	S	2	4	2	Y	R	W	10.0
1	S	1	4	2	Y	R	W	10.0
2	S	1	3	1	Y	R	W	10.0

Sample number	Accession number	Name of variety	Source	Days to flower	Node of 1st flower	Colour of leaf	Number of productive branches	Height of plant	Colour of flower
				1	2	3	4	5	6
160	PLP 300		U.P.	5	3	BG	5	5	W
161	301		U.P.	5	3	BG	2	5	W
162	303		U.P.	4	2	BG	4	5	W
163	304		U.P.	5	3	BG	3	5	W
164	309		U.P.	5	2	BG	3	4	W
165	310		U.P.	4	2	BG	3	4	W
166	311		U.P.	5	2	BG	5	5	W
167	312		U.P.	5	3	BG	4	5	W
168	313		U.P.	5	3	BG	5	5	W
169	314		U.P.	5	3	BG	4	5	W
170	315		U.P.	5	3	BG	4	5	W
171	318		U.P.	5	2	BG	4	5	W
172	319		U.P.	5	4	BG	3	5	W
173	320		U.P.	5	3	BG	5	5	W
174	321		U.P.	5	2	BG	4	4	W
175	322		U.P.	5	2	BG	3	5	W
176	326		U.P.	5	2	BG	3	5	W
177	328		U.P.	5	3	BG	5	5	W
178	329		U.P.	5	2	BG	3	4	W
179	330		U.P.	5	2	BG	5	5	W
180	332		U.P.	5	2	BG	5	5	W
181	333		U.P.	5	2	BG	3	5	W
182	334		U.P.	3	2	BG	2	3	W
183	336		U.P.	5	2	BG	4	5	W
184	337		U.P.	5	2	BG	4	4	W
185	338		U.P.	5	3	BG	4	4	W
186	340		U.P.	5	2	BG	4	5	W
187	342		U.P.	5	2	BG	3	4	W
188	343		U.P.	5	3	BG	4	4	W
189	344		U.P.	5	3	BG	2	3	W
190	347		U.P.	5	2	BG	2	5	W
191	350		U.P.	5	2	BG	5	5	W
192	352		U.P.	6	3	BG	3	4	W
193	353		U.P.	5	3	BG	4	5	W
194	355		U.P.	5	3	BG	3	4	W
195	362		U.P.	5	2	BG	4	4	W
196	363		U.P.	5	2	BG	5	5	W
197	364		U.P.	4	2	BG	3	4	W
198	366		U.P.	5	2	BG	2	4	W
199	367		U.P.	5	3	BG	4	4	W

Length of pod	Shape of pod	Number of pods/ pedunole	Number of pods/ plant	Seeds/ pod	Colour of ripe seed	Shape of seed	Colour of hilum	100-grain weight (gm.)
7	8	9	10	11	12	13	14	15
1	S	1	5	1	Y	R	W	8.0
2	S	1	3	2	Y	R	W	10.0
2	S	1	4	2	Y	R	W	12.0
2	S	2	3	2	Y	R	W	8.0
2	S	2	3	3	Y	R	W	10.0
1	S	1	3	2	Y	R	W	12.5
1	S	1	5	2	Y	R	W	9.5
1	S	2	4	2	Y	R	W	8.0
1	S	1	4	2	Y	R	W	12.0
2	S	1	4	2	Y	R	W	10.0
1	S	2	4	2	Y	R	W	7.0
1	S	1	4	1	Y	R	W	10.0
3	S	2	3	2	Y	R	W	13.0
2	S	2	4	2	Y	R	W	8.0
2	S	2	3	2	Y	R	W	9.0
2	S	2	3	2	Y	R	W	9.0
2	S	2	4	2	Y	R	W	8.0
2	S	2	3	2	Y	D	W	10.0
2	S	1	3	2	Y	R	W	6.0
2	S	1	4	2	Y	R	W	14.0
2	S	1	5	2	Y	R	W	23.5
1	S	2	4	2	Y	R	W	10.0
2	S	2	3	2	Y	R	W	9.0
1	S	2	3	1	Y	R	W	9.0
1	S	2	3	1	Y	R	W	10.0
1	S	2	4	2	Y	R	Bl	10.5
1	S	2	5	1	Y	R	W	14.0
2	S	2	3	2	Y	R	W	6.0
1	S	2	3	1	Y	R	W	12.0
1	S	2	2	1	Y	R	W	13.0
1	S	1	3	1	Y	R	W	10.0
2	S	2	4	2	Y	R	Bl	8.0
2	S	2	2	2	Y	R	W	12.0
1	S	2	4	2	Y	R	W	12.0
2	S	1	3	1	Y	R	W	8.0
2	S	2	4	2	Y	R	W	9.0
2	S	2	3	2	Y	R	W	10.0
2	S	2	4	2	Y	R	W	13.0
2	S	2	2	2	Y	R	W	12.0
2	S	2	3	2	Y	R	W	12.0

Sample number	Accession number	Name of variety	Source	Days to flower	Node of 1st flower	Colour of leaf	Number of productive branches	Height of plant	Colour of flower
				1	2	3	4	5	6
200	PLP 368		U.P.	6	3	BG	4	4	W
201	370		U.P.	5	2	BG	3	4	W
202	371		U.P.	5	3	BG	5	5	W
203	372		U.P.	5	3	BG	4	5	W
204	376		U.P.	5	3	BG	3	5	W
205	377		U.P.	6	4	BG	4	5	W
206	379		U.P.	6	4	BG	4	5	W
207	380		U.P.	6	4	BG	4	5	W
208	381		U.P.	5	3	BG	5	5	W
209	385		U.P.	6	3	BG	4	5	W
210	386		U.P.	6	3	BG	4	5	W
211	387		U.P.	6	4	BG	5	4	W
212	390		U.P.	6	3	BG	4	4	W
213	391		U.P.	6	3	BG	4	5	W
214	392		U.P.	5	3	BG	4	5	W
215	392A		U.P.	5	3	BG	4	4	W
216	393		U.P.	6	4	BG	4	4	W
217	395		U.P.	6	4	BG	4	5	W
218	396		U.P.	5	3	BG	4	5	W
219	397		U.P.	6	3	BG	-	-	W
220	398		U.P.	5	3	BG	5	5	W
221	399		U.P.	6	4	BG	5	4	W
222	401		U.P.	6	4	BG	4	5	W
223	402		U.P.	6	3	BG	3	5	W
224	406		U.P.	4	3	BG	2	4	W
225	407		U.P.	4	2	BG	3	5	W
226	410		U.P.	6	3	BG	4	5	W
227	411		U.P.	5	3	BG	3	3	W
228	412		U.P.	6	3	BG	3	4	W
229	421		U.P.	6	3	BG	4	4	W
230	426		U.P.	5	3	DG	4	5	W
231	428		U.P.	4	2	BG	5	4	W
232	432		U.P.	5	2	BG	4	5	W
233	433		U.P.	5	1	BG	5	5	W
234	437		U.P.	6	3	BG	4	5	W
235	441		U.P.	6	3	BG	2	4	W
236	442		U.P.	6	2	BG	2	5	W
237	449		U.P.	5	3	BG	3	4	W
238	452		U.P.	5	2	BG	2	4	W
239	455		U.P.	5	2	BG	3	4	W

Length of pod	Shape of pod	Number of pods/ pedunole	Number of pods/ plant	Seeds/ pod	Colour of ripe seed	Shape of seed	Colour of hilum	100-grain weight (gm.)
7	8	9	10	11	12	13.	14	15
2	S	2	4	2	Y	R	W	12.0
2	S	1	3	2	Y	R	W	12.5
2	S	2	5	2	Y	R	W	12.0
2	S	2	4	1	Y	R	W	12.0
2	S	2	3	2	Y	R	W	13.0
2	S	2	4	2	Y	R	W	14.0
2	S	2	4	2	Y	R	W	14.0
2	S	2	5	2	Y	R	W	11.0
2	S	2	6	2	Y	R	W	12.0
1	S	2	4	2	Y	R	W	11.0
2	S	2	4	2	Y	R	W	11.5
1	S	2	4	2	Y	R	W	12.0
2	S	2	4	2	Y	R	W	12.5
1	S	2	4	2	Y	R	W	9.0
1	S	2	6	2	Y	R	W	12.5
1	S	2	4	2	Y	R	W	12.0
2	S	2	4	2	Y	R	W	14.5
2	S	2	3	2	Y	R	W	10.0
2	S	2	5	2	Y	R	W	13.0
2	S	2	-	2	Y	R	W	10.0
2	S	2	4	2	Y	R	W	11.0
2	S	2	5	2	Y	R	W	13.0
2	S	2	5	2	Y	R	W	12.5
2	S	2	4	2	Y	R	W	13.0
2	S	2	3	2	Y	R	W	13.0
1	S	2	5	2	Y	R	W	9.0
1	S	2	4	2	Y	R	W	11.5
2	S	2	2	2	Y	R	W	15.0
2	S	2	4	2	Y	R	W	12.0
2	S	2	4	2	Y	R	W	11.0
2	S	2	5	2	Y	R	W	11.0
2	S	1	5	1	Y	R	W	13.0
2	S	1	4	2	Y	R	W	13.0
2	S	1	4	2	Y	R	W	12.0
2	S	1	3	1	Y	R	W	12.5
2	S	2	3	2	Y	R	W	10.0
1	S	1	3	1	Y	R	W	13.0
2	S	1	3	2	Y	R	W	10.5
2	S	1	3	2	Y	R	W	13.0
1	S	1	3	2	Y	R	W	12.0

Sample number	Accession number	Name of variety	Source	Days to flower	Node of 1st flower	Colour of leaf	Number of productive branches	Height of plant	Colour of flower
				1	2	3	4	5	6
240	PLP 458		U.P.	5	2	BG	3	4	W
241	459		U.P.	5	2	BG	5	4	W
242	461		U.P.	5	3	BG	3	4	W
243	462		U.P.	5	2	BG	3	3	W
244	463		U.P.	5	2	BG	5	5	W
245	466		U.P.	5	2	BG	3	4	W
246	467		U.P.	5	1	BG	3	4	W
247	468		U.P.	5	2	BG	3	4	W
248	469		U.P.	5	2	BG	4	4	W
249	470		U.P.	5	2	BG	2	4	W
250	471		U.P.	5	2	BG	4	5	W
251	478		U.P.	5	2	BG	5	5	W
252	480		U.P.	6	4	BG	3	5	W
253	483		U.P.	5	2	BG	4	5	W
254	489		U.P.	6	4	BG	2	4	W
255	490		U.P.	5	3	BG	4	4	W
256	493		U.P.	6	3	BG	4	5	W
257	495		U.P.	6	3	BG	4	5	W
258	498		U.P.	6	4	BG	4	5	W
259	501		U.P.	5	2	BG	4	5	W
260	502		U.P.	4	3	BG	3	5	W
261	504		U.P.	5	3	BG	3	3	W
262	505		U.P.	5	2	BG	3	3	W
263	506		U.P.	5	2	BG	3	4	W
264	509	BR 12	Bihar	6	3	BG	3	4	W
265	510	BR 2	Bihar	5	2	BG	4	4	W
266	515		Mysore	3	2	BG	3	4	W
267	516		Mysore	3	2	BG	4	3	W
268	517		Tamilnadu	4	3	BG	2	4	W
269	518		Tamilnadu	3	2	BG	3	3	W
270	519		Tamilnadu	3	2	BG	4	3	W
271	520		Tamilnadu	4	2	BG	4	4	W
272	521		Tamilnadu	3	1	BG	3	4	W
273	523		Tamilnadu	4	2	BG	3	4	W
274	524		Tamilnadu	5	2	BG	4	4	W
275	525		Tamilnadu	3	2	BG	4	3	W
276	527		Tamilnadu	4	2	BG	2	4	W
277	528		U.P.	5	2	BG	4	4	W
278	564		H.P.	6	3	BG	5	5	W
279	565		H.P.	6	4	BG	5	3	W
280	566		H.P.	5	3	BG	4	3	W

Length of pod	Shape of pod	Number of pods/ peduncle	Number of pods/ plant	Seeds/ pod	Colour of ripe seed	Shape of seed	Colour of hilum	100-grain weight (gm.)
7	8	9	10	11	12	13	14	15
1	S	1	5	2	Y	R	W	10.0
2	S	2	5	2	Y	R	W	10.0
2	S	1	3	2	Y	R	W	9.0
2	S	1	3	2	Y	R	W	10.0
2	S	2	5	2	Y	R	W	9.5
2	B	1	4	1	Y	R	W	10.5
2	S	1	3	2	Y	R	W	10.5
2	S	2	2	2	Y	R	W	10.0
2	S	1	4	2	Y	R	W	7.5
2	S	1	3	2	Y	R	W	12.0
2	S	2	3	2	Y	R	W	9.5
2	S	2	4	2	Y	R	W	8.0
1	S	2	2	1	Y	R	W	9.0
1	S	2	4	1	Y	R	W	13.0
2	S	2	3	2	Y	R	W	11.5
2	S	2	3	1	Y	R	W	12.0
2	S	2	3	1	Y	R	W	11.0
2	S	2	5	2	Y	R	W	12.5
2	S	2	4	2	Y	R	W	11.0
2	S	2	3	2	Y	R	W	13.0
2	S	2	4	2	Y	R	W	12.0
2	S	1	4	2	Y	R	W	15.0
2	S	2	4	2	Y	R	W	10.0
2	S	1	4	2	Y	R	Bl	10.0
2	S	1	4	2	Y	R	Bl	13.0
2	S	2	3	2	Y	R	Bl	14.0
2	S	2	3	2	Y	R	W	13.0
2	S	2	4	2	Y	R	W	11.0
2	S	1	3	1	Y	R	W	10.0
1	S	1	4	1	Y	R	W	13.0
2	S	2	3	2	Y	R	W	10.0
2	S	2	3	2	Y	R	W	10.5
3	S	2	4	1	Y	R	W	14.0
1	S	2	4	1	Y	R	W	9.0
1	S	2	4	1	Y	R	W	9.0
2	S	2	3	2	Y	I	W	8.0
2	S	1	3	2	Y	R	W	12.0
2	S	2	3	2	Y	R	W	10.0
2	S	2	3	2	Y	R	W	8.0
2	S	2	3	2	Y	R	W	8.0
2	B	2	3	2	Y	R	Bl	17.0

Sample number	Accession number	Name of variety	Source	Days to flower	Node of 1st flower	Colour of leaf	Number of productive branches	Height of plant	Colour of flower
				1	2	3	4	5	6
281	PLP 567		H.P.	5	3	BG	4	3	W
282	568		H.P.	6	3	BG	4	3	W
283	569		H.P.	5	3	BG	4	4	W
284	570		H.P.	4	2	BG	4	5	W
285	576		H.P.	3	2	DG	3	2	W
286	578		H.P.	5	3	BG	5	3	W
287	582		H.P.	5	2	DG	4	2	W
288	586		H.P.	6	3	BG	5	3	W
289	592		H.P.	4	2	DG	4	2	W
290	594		H.P.	4	2	DG	3	3	W
291	599		H.P.	5	3	BG	4	4	W
292	600		H.P.	5	2	BG	4	4	W
293	601		H.P.	5	3	BG	5	5	W
294	604		H.P.	5	3	BG	3	5	W
295	607		H.P.	5	3	BG	3	5	W
296	608		H.P.	5	1	BG	4	5	W
297	610		H.P.	5	2	BG	3	5	W
298		Kanpur sel.	U.P.	5	3	BG	4	5	W
299		Patna Queen	U.P.	5	2	BG	5	5	W
300		N.P.5	New Delhi	5	3	BG	4	5	W
301			New Delhi	2	1	BG	4	4	W
302			New Delhi	3	2	BG	2	4	W
303	I.C. 79		J & K	5	2	BG	4	5	W
304	80		W. Bengal	5	3	BG	4	5	W
305	640		M.P.	5	2	BG	4	5	W
306	649		Maharashtra	5	2	BG	5	5	W
307	683		Delhi	6	4	BG	5	5	W
308	700A		Delhi	5	2	BG	4	4	W
309	755		Maharashtra	6	4	BG	4	5	W
310	773		U.P.	5	2	BG	2	3	W
311	774		U.P.	4	2	BG	2	3	W
312	776		U.P.	5	3	BG	5	4	W
313	968		H.P.	5	2	BG	3	4	W
314	1277	I.P.163	U.P.	5	3	BG	3	5	W
315	1326	T. 21	U.P.	4	2	BG	4	4	W
316	1337		Bihar	5	3	BG	5	4	W
317	1412		U.P.	5	2	BG	3	4	W
318	1435		U.P.	3	2	BG	3	4	W
319	1436		U.P.	5	2	BG	3	4	W
320	1446		U.P.	5	2	BG	3	5	W

Length of pod	Shape of pod	Number of pods/ peduncle	Number of pods/ plant	Seeds/ pod	Colour of ripe seed	Shape of seed	Colour of hilum	100-grain weight (gm.)
7	8	9	10	11	12	13	14	15
2	S	2	4	1	Y	R	Bl	15.0
2	S	2	3	2	Y	R	W	14.0
5	S	2	3	3	Y	R	Bl	19.0
2	S	2	4	2	Y	R	Bl	20.0
3	B	1	4	3	Y	D	W	15.0
1	S	2	3	1	Y	D	W	9.5
3	B	2	3	3	Y	D	W	12.0
2	S	2	4	2	Y	R	Bl	15.0
3	B	1	4	3	Y	D	W	16.0
3	B	1	4	3	Y	D	W	16.0
2	S	2	4	2	Y	R	Bl	15.0
2	S	2	4	2	Y	R	Bl	12.0
2	S	2	3	2	Y	R	Bl	11.0
2	S	2	3	2	Y	R	W	13.0
2	S	2	3	2	Y	R	W	13.0
2	S	2	4	2	Y	R	W	14.0
4	B	2	6	2	Y	R	Bl	20.0
1	Sic	1	4	2	Y	R	W	12.0
2	S	1	4	2	Y	R	W	11.0
2	S	2	5	2	Y	D	W	12.0
3	S	1	2	2	Y	R	Bl	14.0
2	S	2	3	2	Y	R	W	15.0
3	S	2	4	3	Y	R	Bl	13.0
2	S	2	5	2	Y	R	Bl	17.5
2	S	1	3	1	Y	R	W	14.0
2	S	2	5	2	Y	R	Bl	14.5
2	S	2	5	2	Y	R	Bl	13.0
2	S	1	3	2	Y	R	Bl	10.0
2	S	2	4	2	Y	R	W	12.0
2	S	1	3	1	Y	R	W	23.0
2	S	1	3	2	Y	R	W	10.0
2	S	2	4	2	Y	R	Bl	11.0
2	S	1	4	2	Y	R	Bl	17.5
3	S	2	4	2	Y	R	Bl	20.0
2	S	2	2	1	Y	R	Bl	9.5
2	S	2	4	2	Y	R	W	14.0
2	S	1	3	1	Y	R	W	10.0
2	S	2	2	3	Y	R	W	10.5
2	S	2	4	2	Y	D	W	12.0
1	S	2	4	2	Y	R	W	12.5

Germplasm and the Phytopathologist

First Contribution to a Discussion

by
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INTRODUCTION

In the search for germplasm resources, as well as in breeding, it should be emphasised that disease resistance differs from other traits. In the sense in which it is commonly understood, disease resistance is mostly a temporary achievement, which is eventually overcome by new strains of the pathogen. Disease resistance is also a special trait since it cannot be identified without the use of the pathogen in question. The relevant pathogens differ in different regions and resistance against the unknown pathogenic strains of the future cannot be determined today. Resistance is also a special case of genetic expression; it is a common expression of many different genotypes. All these facts indicate that the topic of germplasm resources for disease resistance merits a special approach. The following remarks and proposals crystallised to their present form while participating in the FAO Technical Conference on Crop Genetic Resources held in Rome from 12 to 16 March 1973.

EXPLORATION AND COLLECTION OF MATERIAL

Disease resistance in primitive varieties and populations of wild plants is distributed in an unpredictable manner. Material sampled at many different points over a large area can serve, after proper evaluation, for the establishment of distribution maps of any character evaluated. The material from randomly well-scattered points of sampling can be evaluated in different centres for specific requirements. Mapping of resistance can point out hot-spots of more rapid evolution of host-parasite relationships. The more of the distribution area of a given species, or rather crossable species of a given genus, that is covered the better are the chances of finding more sources of resistance.

EVALUATION

The results and the significance of evaluation depend strictly on the pathogens used. Resistance to one disease is usually independent of resistance to another. The chance of a single plant being resistant to more than one race of a particular disease is less than that of being resistant to one race only. Resistance to several diseases or races is constructed by the plant breeder by recombining different sources of resistance to specific race or diseases. But it is a waste of precious material to screen it with a bulk of races or a mixture of different pathogens, as is normally done either in the greenhouse or by growing collections out in the field where several diseases and several races of the same disease are present.

Evaluation for disease resistance should be performed separately in each region according to local needs, by using the relevant races of the relevant pathogens. Since the evolution of host-parasite relationships is going on in different directions and at different rates in various places, it would not be wise to centralise evaluation. There is no sense in assembling pathogenic cultures from different regions, or by the same token, in breeding new and more virulent cultures. This has and is being done either in anticipation of future events or for the sake of avoiding the masking effects of vertical resistance on selection

for horizontal resistance. It is suggested by us that screening for present needs be conducted in each region separately. If future events are to be anticipated or the distinction between different genes for resistance is needed, plant material should be sent to other centres where relevant cultures are part of the existing populations of pathogens. The same applies to screening for horizontal or field resistance. It is known that vertical or major gene resistance masks horizontal resistance. If the existing cultures in one centre do not overcome the major gene resistance they cannot serve for evaluation of horizontal resistance. Plant material in these cases should be sent for evaluation to another centre where pathogenic strains are present that can overcome the vertical resistance in question.

Centralisation of evaluation for disease resistance has two more aspects, the interests of the screening centre and the interests of those benefitting from this centre. Evolution takes different directions in various areas, as mentioned before. The first aspect, therefore, is that evaluation in a centre should be conducted according to immediate needs. Resistance selected should be the simplest needed, only against existing races in that area. The use of a super source of resistance is a waste of resistance. New and so far unneeded sources should of course be held in reserve to face a sudden breakdown of resistance, but they should not be used when not needed or when simpler sources are sufficient. This strategy will save us time in the unending competition with the pathogen. Since, after all, the evolution of virulence in the pathogens is "man-guided", let it be guided slowly wherever possible. There are good examples today, like the case of oat crown rust resistance in the Mediterranean region compared with Scandinavia, where sources of resistance that are already worthless in one region are excellent in another region. This other region has, therefore, a reserve of several safe years that is lacking in the first. The second aspect concerns the distribution of sources of resistance from a centre to many various regions. From a phytopathological viewpoint one of the problems of modern agriculture is that it is composed of an assembly of monocultures. Homogeneous populations of hosts are much more vulnerable to the attack of newly developed races of pathogens. The spread of a uniform, homogeneous genetic background over large areas exposes a most suitable medium for a fast spread of epidemics. The quite recent catastrophe in maize in the U.S.A. caused by the Southern leaf blight is a shocking illustration of a potential disaster due to the spread of homogeneous genetic background Therefore, it is imperative that the newly suggested tactics of zonation in the use of sources of resistance be adopted as a general policy. The exact details of how to achieve this in practice should be discussed between or among centres concerned.

When diseases caused by heterokaryotic fungi are concerned, the problem seems to be more complicated and further thorough research into the genetic and epidemiological aspects of it should be undertaken.

Another special and important case is the case of field or horizontal resistance. As far as things stand today this seems to be a more stable and reliable type of resistance. There are several difficulties with this type of resistance, but they will not be discussed here. With this type of resistance two things should be mentioned: (i) vertical or monogenic resistance should not be sacrificed for the sake of detecting and identifying this type of resistance; (ii) centralisation in the evaluation of this type of resistance is possible and can even be recommended to take place in those areas where the concerned pathogen has reached a most advanced state in the evolution of virulence. This suggestion will of course need very close cooperation between any breeding centre and the evaluation centre concerned.

PRESERVATION

Preservation in the form mostly recognised today means taking parts from existing populations and "freezing" them, evolutionarily speaking, in their present status. Where native populations or primitive cultivars that face extinction are concerned, this might be the most efficient method at the moment to save them from extinction. Especially from a phytopathological viewpoint, it means that a very important process, the development of new sources of resistance, is being arrested.

A better solution I think would be to establish nature reserves where these populations will exist and will continue to evolve. Some would prefer to call these "genetic reserves", but the idea is the same. Nature reserves can serve several different purposes, like national parks, which are field laboratories for botanists and other students, as well as living museums. These reserves can and should include cultivation of primitive cultivars under primitive conditions to ensure the continuation of evolutionary processes being stopped by modern agriculture. Sites for nature reserves should be chosen also in centres of diversity and, if information is available, also in areas where disease resistance is more concentrated.

RESUME/RESUMEN

Les ressources génétiques et le phytopathologiste

La resistance aux maladies diffère des autres caractères génétiques par bien des aspects et exige une approche spécifique en ce qui concerne la collection et l'évaluation. Tant d'abord, étant donné que la distribution géographique de la résistance aux maladies est imprévisible, les collections doivent couvrir la totalité de l'aire de distribution géographique de l'espèce-hôte. Ensuite, la variation dans la distribution des populations des organismes pathogènes nécessite l'évaluation du matériel vegetal dans le plus grand nombre possible de centres. Le matériel végétal à evaluer devrait être échangé entre centres appartenant à des régions différentes afin d'utiliser les différences régionales existant entre populations pathogènes pour une sélection visant à la fois la résistance verticale et horizontale aux maladies. La sélection devrait viser à résoudre les problèmes immédiats par l'usage des seules sources de resistance directement appropriées. Les autres sources de resistance devraient être tenues en réserve afin de pallier à de soudaines pertes de résistance. La distribution à grande échelle de variétés génétiquement homogènes devrait être évitée par l'adoption d'une approche zonale de la sélection exploitant la variation regionale existant dans les caractères génétiques de résistance et dans les populations pathogènes. La conservation des caractères génétiques de résistance pourrait probablement être assurée par la création de "reserves naturelles" où les espèces-hôtes et les populations pathogènes pourraient continuer à evolver en contact les unes avec les autres.

Germoplasma y el Fitopatólogo

Resistencia a las enfermedades difiere de otros aspectos genéticos en varias formas requiriendo un enfoque especial en cuanto a colección y evaluación. En el primer caso, debido a que la distribución geográfica es impredecible, las colecciones deben intentarse que cubran la total área de distribución de las especies hospedantes. En el segundo caso, la variación en la distribución de razas patogénicas necesita de una evaluación de germoplasma en muchos centros como sea posible; el material vegetal para evaluación debiera intercambiarse entre los centros en diferentes regiones a fin de hacer uso de variaciones regionales en poblaciones de patógenos al seleccionar para ambos tipos de resistencia, vertical y horizontal. La estrategia de mejoramiento debe intentar resolver problemas inmediatos haciendo uso solamente de fuentes de resistencia apropiadas. Otras fuentes de resistencia deben ser mantenidas en reserva para combatir un repentino quiebre de la resistencia. La amplia distribución de variedades genéticamente homogéneas debiera evitarse adoptando un enfoque zonal en el mejoramiento, explotando la variación regional de genes de resistencia y en las poblaciones de patógenos. La conservación de genes de resistencia puede posiblemente obtenerse en mejor forma, creando "reservas naturales" donde la planta hospedante y las poblaciones de patógenos pueden continuar evolucionando en contacto unos con los otros.

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